

vary inversely) and conclude that our race was becoming the very salt of the earth. But we are strongly convinced that Dr. Saleeby's optimistic interpretation is erroneous, and that the further one goes into the details of the dwindling birth-rate the more suggestive of impending disaster it seems. The author seems to us to have confused two quite different phenomena, a specific constitutional change and a social artificial change.

(3) It is surprising to us that an investigator of Dr. Saleeby's acuteness should have failed to realise the fact of "reproductive or genetic selection" (see p. 40). There is a mode of natural selection which works not by death, but by handicapping parenthood. In a second edition the author should surely utilise for his eugenist argument what is one of the most certain modes of selection.

(4) It grieves us that Dr. Saleeby should take his conception of the struggle for Existence and Natural Selection from Sir Ray Lankester rather than from Darwin, and that he should thus favour the persistence of a pernicious error. Here we agree with Mr. Balfour, not with his critic. Darwin recognised the struggle between near kin, the struggle between unrelated foes, the struggle between organisms and their inanimate environment; he assigned importance to each of these. Even when we take Darwin's paragraph headed "Struggle for life most severe between individuals and varieties of the same species; often severe between species of the same genus," we find only five illustrations, and these are not altogether convincing. On these and several other points we entirely disagree with the author, but our agreement in essentials is cordial.

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Bateson, PROFESSOR W., M.A., F.R.S. *Mendel's Principles of Heredity*. Cambridge University Press. Price 12s. 6d.

OF none of us can it as yet be said that we are able to foretell or control our destiny. Still less is it possible to predict the nature or extent of the influence which any deed of ours may exercise upon others. Perhaps it is as well that we do not too often stop to calculate the measure of such influence. The best work of the world and the highest influence which can be exercised by individuals is the product of spontaneity rather than of calculation. We may therefore suppose that when the father of Gregor Johann Mendel "initiated his son at an early age into the methods of plant grafting," he had not the shadow of an idea of the extent to which his paternal influence might

determine his son's future career. But we must be careful not to convey a wrong impression. Influences cannot create or destroy a character; though they may call into activity that which we have inherited. And to this extent only the influence of Mendel's father may have decided the direction of his son's work or recreation.

Gregor Mendel was during part of his life an Abbot, yet there is little in his appearance, as it is depicted in the portrait reproduced in Mr. Bateson's book, to suggest the priest. But there is something manifested in his countenance which escapes analysis; it is evident that he was a kindly and tolerant person, for although the face is wholly masculine, there is that in it which indicates a feminine gentleness and patience with little things. His character was doubtless of a complex nature: possibly there were combined in it the sternest resolution and the sweetest docility; and the academic spirit of the cloister and the college were commingled in happiest harmony with the utilitarian capacity and clear thinking of successful practical life.

Gregor Mendel was not eminent in the popular sense, for he was not a "rope-dancer in the market place," nor a charlatan standing on a self-exalted pedestal, but he was great because he was what Nietzsche would have called a "Creator." He came into a branch of knowledge that was in chaos and he gave us order; he found there stagnation and he converted it into progression; he saw multitudinous facts dead because they had no consistent interpretation, and he gave them life. To appreciate the magnitude of the task that he accomplished and the nature of the debt that posterity owes to him, we must go back and consider the state of hereditary studies in his day.

The most masterly work of the period and one which summarised its knowledge, was Darwin's *Variation of Animals and Plants under Domestication*. This work is a monument of consummate skill, and must ever remain a potent source of inspiration and example for all who love an orderly marshalling of the ascertained truth. But, none the less, one puts it down with an impression that there is no orderly sequence in hereditary phenomena, other than that *in some way* characters are hereditarily transmitted. Why, for instance, should one of eight children and not the others inherit a peculiar habit of the father? Why should some members of the same family possess a single lock of hair differently coloured from the rest, and other members be without it? Why was it breeders could not get a good jonquil-coloured canary by pairing two jonquils? Why, when two crested canaries were paired did they rarely produce crested offspring? Why

was it that the best laced Sebright bantams were bred by the union of heavily-laced birds with those that were scarcely sufficiently laced? Why was it that the colour of the pointer "Sappho" reverted to that of his great-great-grand-maternal ancestor? These and a great many other apparently contradictory and chaotic results were left unexplained by Darwin but are answered to-day as the outcome of the heritage of intellectual penetration which Mendel has bequeathed to us. For Darwin did not seem to view very favourably the hypothesis of segregation. He appeared to be influenced by the opposite conception that characters blend. For he says, "I suspect it would be more correct to say that the elements of both parent-species exist in every hybrid in a double state, namely, blended together and completely separate." And in his theory of Pangenesis he endeavoured to show how these antithetic conditions might possibly coexist.

It is clear that at the time when Mendel published his theory of segregation and the experiments and numerical results upon which it was based, no great importance was attached to it. Somatic or body segregation was recognised as a phenomenon, and perhaps regarded as a consequence, but the idea of gametic or sex-cell segregation was not appreciated as the cardinal link which bound together into a consistent whole much that was disconnected and chaotic in the study of hybrids and of heredity generally. It is clear too, that at this time no one had perceived how necessary it was to determine experimentally the number of different forms under which the offspring of hybrids appear, or to arrange these forms with certainty according to their separate generations, or definitely to ascertain their numerical relations. From the shape which Mendel's experiments took it is evident that he arrived at the conception of gametic or sex-cell segregation as a matter of intellectual perception, and that it did not merely arise as the fruit of experiment. His experiments were based upon his conception; his conception did not arise as the happy accidental result of random experiment. The idea, and the consequences which must flow from it, must have been present to him, therefore, as early as 1857, and perhaps earlier, because we find his experiments extended over eight years, and he first described them and enunciated his theory in 1865. Thus, although Naudin in this latter year apparently came very near to Mendel's conception of gametic segregation, Mendel was the first to appreciate fully its real importance and to see the causal relationship which it bore to the facts of his day.

The three questions which Mendel put to experimental test were : How many forms arise in the offspring of hybrids when self-fertilised ? In which generation do these different forms occur, and how many of each are there ? These were absolutely new in his day. It is easy now to appreciate the beautiful simplicity of these questions. But it required considerable intellectual penetration to discern the two ends of the thread in the confused and knotted tangle which bewildered every naturalist of that period.

Several great "Whys?" have been answered by the application of Mendel's method and his clue to the problems of Evolution and Inheritance. The reader can read the answers in Prof. Bateson's book. They are there put forward with that admirable and easy lucidity that ever characterises the work of a man who has a masterful grasp of the detailed facts of his subject. Why is it that in some particular character we are like one of our grandparents and not our parents? This is a fact that has been known to us ever since we had our gallery of ancestral pictures; we have noted it and marvelled and talked of it in our family circles, but the answer has never been forthcoming until now. It is given by Mendel's proof of gametic segregation and gametic purity. Mendel demonstrated these phenomena in his classical experiments on peas, and Mr. Hurst, following Mendel's methods and guided by his clue, has demonstrated them for one character in Man, namely, eye-colour. In the book now under review the reader will find a chart of two pedigrees showing the Mendelian inheritance of this character, accompanied by a statement of the general features of the related phenomena.

Speaking in general language, we may say that Mr. Hurst's observations show there are two chief types of eye-colour in Man. There is the one where brown pigment, in greater or smaller quantity, is present on the outer (front) surface of the iris. Such eyes present various shades of colour and marking, according to the amount, concentration, and distribution of the brown pigment. They range from a grey colour, with very little of such pigment, through the hazel, green, light brown to dark brown and black eyes, with respectively increasing amounts of such pigment. If this brown pigment is entirely absent, there results a pure blue or blue-grey eye. The pigment which produces this blue colour is really a purple one, situated on the inner (back) surface of the iris. It is present also in the eyes which contain brown pigment. Mr. Hurst speaks of the blue eyes as a "Simplex" type and those containing brown pigment as a "Duplex" type.

Now an important feature that it is necessary to note here, is the nature of the real difference between these two types of eye. Both contain the purple pigment, but the blue eyes are those without the brown pigment, and the brown ones are those in which it is present. The essential character that we have to deal with, therefore, is, as Mr. Hurst has shown, the absence or presence of brown pigment. Just as with an albino and a pigmented animal, the real phenomenon which presents itself is not one of a coloured animal *versus* a white animal, but of an animal in which colour is present, *versus* one in which it is absent. In other words, the essential consideration we are called upon to understand is, not that a blue eye or an albino is something generically distinct, in the sense that it is another quality, having no relation to brown eye or to a coloured animal respectively, but that the one is simply the other from which something is absent. Blue eye is brown eye without the brown pigment; an albino is the coloured organism without that factor which by its presence produces colour. This leads us to an exceedingly important conception which is formulated in what is now known as the "Presence and Absence" hypothesis.

We owe this valuable and illuminative generalisation to the Cambridge School, to Prof. Bateson and Mr. R. C. Punnett. The birth of this hypothesis is of sufficient interest to justify some consideration of it here. Mendel in his experiments dealt with some seven pairs of alternative characters of the peas which he investigated. And he stated the nature of each pair of characters, essentially as follows. The ripe seeds were "rounded" or "wrinkled" in form; the seed colour—due not to the seed coats but to the fleshy cotyledons within—was "yellow" or "green"; the seed colour due to their investing coats, was "white" or "grey-brown"; the length of stem was "tall"—some six to seven feet in height, or "short"—about three-quarters of a foot to a foot and a half in height; the ripe pods were "inflated" or "constricted"; or they were "green" or "yellow" in colour; the flowers were purple or white; and they were either terminal in situation on the stem, or arranged laterally along its length.

Let us consider one pair of these alternative characters, in order that we may appreciate the distinction in the symbolic representation of them which we now employ and that which Mendel used. He would, for instance, in regard to height, have conceived that the gametes or sex-cells (*i.e.*, egg or female cells and pollen or male cells) would have separately carried, in the one cell, a something (let us

call it a factor) which determined tallness, and in the other, a something which determined shortness. In other words, he doubtless conceived of tallness as being one quality and shortness as another. But the underlying conception of the "Presence and Absence" hypothesis, expresses the idea that "shortness" is merely absence of "tallness." That is, the dwarf plant is one which depends upon the possession of some factor determining the degree of its dwarfness, but the tall plant is the dwarf plant to which an additional factor determining tallness has been added. The dwarfness factor is common to both and may therefore in any symbolic representation of dwarfness and tallness be eliminated. We can then represent the factors concerned in terms of the presence or absence of tallness. If tallness is taken away, the common character dwarfness remains and the plant is short. If tallness is added, dwarfness though present, is no longer manifest because tallness dominates it, and the plant is tall.

Let the reader try to form a concrete image of this conception. Let him take two pieces of glass, one coloured red and the other colourless. The substance of the glass is common to both, and we may symbolically represent the coloured glass as "presence of red" and of the colourless glass as "absence of red." There is no need to introduce the conception that coloured glass is one thing and colourless glass is quite another. Add red to the latter and we have the former; take red from the former and we obtain the latter.

Now, as a matter of fact, so long as we are dealing with the alternative pairs of characters considered in Mendel's experiments, and with a number of others, each system of symbolical representation expresses the experimental facts equally well. We may express our conceptions in terms of purple flower *versus* white flower, and tall stem *versus* short stem, or in the alternative way as "presence of purple" *versus* "absence of purple," and "presence of tallness" *versus* "absence of tallness." Either description is equally consistent with the experimental data. But in the course of his prolonged experiments with fowls in which the hereditary behaviour of the comb character was under investigation, Prof. Bateson found that a consistent description of the results was not possible if it was attempted in terms of "single comb *versus* pea-comb," or "single comb *versus* rose comb," or "single comb *versus* walnut comb," or "rose comb *versus* pea-comb," and similarly for all the possible combinations of these four different kinds of combs. On the other hand, the whole of the somewhat complex experimental results received a very simple

and wholly consistent interpretation on the "Presence and Absence" hypothesis. It is only necessary to suppose that there exist two pairs of alternative or allelomorphic characters and the whole range of facts, derived from the breeding of twelve thousand five hundred chicks and hens, falls at once into an orderly scheme. The two paired alternative characters which it is assumed exist are presence and absence of the rose character as one pair, and presence and absence of the pea character as the other. Absence of either the pea or rose character leaves us with the single comb. A hybrid produced by the mating of rose comb with pea comb is known to bear a walnut comb. We are thus led to conceive of singleness as a kind of physical basis common to all types of combs. Add to it the factor which produces roseness and we have it modified to form a rose comb. But add to it the factor for peaness and the modification thus induced gives a pea-comb. A rose comb is therefore regarded as a single comb in which roseness is present but peaness is absent; and a pea comb is similarly a single one where peaness is present and roseness is absent. If both factors, namely roseness and peaness, are present together in the same individual there is produced a new character, the walnut comb.

There was one feature in Mendel's experiments which had to be accepted as a fact, but which received no explanation at the time. It is the phenomenon of dominance. No interpretation of this was forthcoming until the formulation of the "Presence and Absence" hypothesis. But this hypothesis enables us to attempt some sort of interpretation of dominance. For clearly, the dominance of a character is but the expression of its presence and the recessiveness of a character is similarly the manifestation of its absence. When, in the case where we cross a tall pea with a short pea, all the offspring are like the tall parent, we have to conceive that it is something similar to the hiding of a short man behind a taller one. And when a purple flower is crossed with a white one, and all the offspring are purple, we are forced to believe that an analogy may be found in the disappearance of the whiteness of the cartridge paper wherever the artist has applied his colour.

The reader of Prof. Bateson's book will find a great deal of matter of absorbing interest. He will find problems that have escaped elucidation for centuries, growing under the newer light of the Science of Genetics. At last we see the only way by which problems of inheritance can be effectually and scientifically attacked. The facts of geographical distribution, of the inter-relationship of

species on the overlapping bounds of their common territory, may suggest problems for investigation, but they cannot by themselves supply a truthful answer. The problems of evolution and of variation to-day give promise of receiving correct answers. We cannot, of course, yet close the book of knowledge, for we have only just passed its preface and reached its first real page ; but we no longer grope in semi-darkness, for now we have a method by which we can put to Nature a single definite question, and get from her a single and definite answer to every question we choose to put. That is an enormous gain. This method is the most powerful instrument biological science has ever wielded, and the intellectual conception that lies behind it and supplies the motive power must be ranked among the greatest of her victorious achievements.

With regard to Man, it is now clear that what medicine, social reform, legislation and philanthropy have failed to accomplish, can be achieved by biology. Tell the student of Genetics what type of nation we desire, within the limits of the characters which the nation already possesses, and confer upon him adequate powers, and he will evolve it. It is not too much to say that if he were instructed to evolve a "fit" nation—that is, one of self-reliant and self-supporting individuals—in the course of a few generations there would be neither workhouses, hospitals, unemployables, congenital criminals, or drunkards.

Students of Eugenics will turn with interest to the concluding pages of Prof. Bateson's book ; there he deals with the sociological application of the Science of Genetics. We commend every advocate of social panaceas and of legislative interference with natural processes to read this part of the book. In a few well-chosen sentences, he gives expression to the judgment of every biologist, alike of the present and the past, who has given to social problems adequate and unbiassed thought. For nothing is more evident to the naturalist, than that we cannot convert inherent vice into innate virtue, nor change "leadens instincts into golden conduct," nor "transform a sow's ear into a silken purse," by any known social process. Our vast and costly schemes of free compulsory elementary education, of County Council Scholarships and evening classes, which are among these social processes supposed to possess the magic virtue of transforming the world into a fairy land, may be a delusion and a danger. And so, too, may be all the other well-intentioned but costly panaceas that harass, and tax and eventually destroy the fit in order to attempt—for they can never achieve—the salvation of the unfit.

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